Appendix A – Ecological Risk Assessment Summary

A.1 Introduction

In 1991, a Consent Decree between Ecology, Weyerhaeuser, and DuPont was signed. The MTCA regulations, as well as the Consent Decree, require that potential risks to human health and the environment be evaluated at the Site. This memo summarizes the qualitative and quantitative evaluations performed to evaluate the potential impacts to ecological receptors at the Former DuPont Works Site.

A.2 Nature and Extent of Contamination

Soil, groundwater, surface water (fresh and marine), and sediment were all potentially impacted from the activities of the Former DuPont Works. Constituent concentrations in these media (except for soil where there are no published standards) were compared to Federal and State environmental standards that are protective of the environment. No constituent concentrations in surface water and fresh water sediments exceeded any of the standards. Based on these comparisons and other factors such as diversity of species in fresh water sediments, it was determined that surface soil is the only medium of potential ecological concern (Hart Crowser, 1994).

Petroleum, DNT, TNT, mercury, arsenic, and lead were detected in soil at the Site. Petroleum, DNT, TNT, and mercury have been remediated and residual concentrations do not pose a risk to upland species of plants and animals. Human health standards for arsenic are protective of ecological organisms. Therefore, remediating arsenic contamination to meet human health standards will ensure protection for ecological receptors. The only remaining COPC for ecological receptors is lead.

The bulk of lead contamination in surface soil at the Site is, in general, localized around building foundations which will be remediated. The removal of soil around these foundations will reduce significantly the overall lead contamination Site-wide, and therefore, the overall risk to ecological receptors. Nevertheless, as currently envisioned, there will remain relatively small areas on the Site where either remediation or active land development are not planned. It is these areas, such as future Open Space and buffer areas, where the potential for exposure of ecological receptors to lead remains. The concerns raised by potential exposure to lead in these areas, and approaches to addressing these concerns is the focus of the following discussion.

A.3 Ecological Risk Assessment

A.3.1 General

Ecological risk assessment is a process that is used to estimate the likelihood and magnitude of harm to ecological receptors that results from exposure to one or more stressors. It is a tool that helps in the decision making process, hence the results of the ecological risk assessment are one of several considerations involved in making the ultimate decision as to what action might need to be taken at a site. In general, the ecological assessment process follows the concept of tiering. The assessment begins with a relatively simple screening process which allows the risk assessor to determine what receptors and what constituents are of concern. If the potential for ecological impacts are not found during this screening step, the assessment ends. If, however, there are potential ecological risks found, the assessment may progress to more complex and lengthy investigations. In this way, evidence is collected in a stepwise fashion allowing the decision maker to determine whether or not additional information is needed to make a scientifically supportable decision. Where sufficient information is available, such that the decision maker is no longer faced with a high degree of uncertainty, there may be no need for further assessment. There are at least two, perhaps more, approaches to ecological risk assessment: the top down approach, and the bottom up approach.

A.3.2 Top Down Approach

The top down approach takes a macro scale view of the existing conditions on-Site, including the plants, animals and habitats, and considers whether or not there are obvious signs of harm. The judgment as to whether or not harm is present is based on a comparison of the area of interest to a similar nearby area where the stressors of concern, such as metals, are not present. If the comparison suggests that there are no obvious signs of harm (i.e., the nearby site is not substantially different than the site of interest), the assessment can typically be stopped. The strength of the top down approach is that the "sum" of the functioning of the plants and animals is measured, and judged against a similar "sum" from a relatively clean area. It is analogous to "taking a big picture view of potential ecological risks". A weakness of this approach is that the resolution, or ability to see small things clearly, is not great enough to observe subtle, micro scale differences that might be present.

A.3.3 Bottom Up Approach

Conversely, the bottom up approach begins by measuring concentrations of constituents in important media, perhaps conducting toxicological tests on these media, and later attempting to integrate these measures into an estimate of ecological risk. The bottom up approach is analogous to viewing the individual trees in the forest and using that information to determine if there has been harm to the total forest. In contrast, the top down approach does not look at individual trees *per se*, but the total forest, to determine if there is potential harm. The strength of the bottom up approach is that discrete measurements of potential exposure and harm to individual components of the system are made, providing both a qualitative and quantitative estimate of potential risk. A weakness of this approach is that the overall functioning of the plants and animals, the "sum" of the system, may or may not match up with the bottom up information. That is, the overall system may be functioning appropriately even when individual components may not be.

At the former DuPont Works Site, both the top down and the bottom up approaches were applied as discussed below. Taken together, the two approaches complement one another and thus reduce the likelihood that either micro scale or macro scale problems are missed.

A.4 Site-Specific Ecological Studies - A Top Down Approach

A number of Site-specific qualitative and quantitative ecological studies have been conducted at the former DuPont Works Site. These included the following:

- **Biological Survey** – Terrestrial ecology studies were conducted from January 1977 through February 1978 to document existing conditions including the diversity and composition of plant and animal species (Melchiors and Motobu, 1978). The investigations included determining the species composition and extent of plant communities, bird, large and small mammals (e.g., mark-recapture trapping of small mammals), reptiles and amphibian populations.

- **Biological Resources Summary (The Weyerhaeuser Export Facility FEIS)** – This document provides a detailed summary of all previous biological investigation work regarding existing flora, fauna, and associated habitats at and in the vicinity of the Site (U.S. Army Corps of Engineers, 1982). The document also provides a series of maps and tables compiling all of the biotic information related to the Site. These data and observations support the conclusion that the former DuPont Works site is a relatively robust ecological area containing a diverse assemblage of plants and animals common to the Pacific Northwest.

- **Biological Resource Assessment** — To update the FEIS and previous work on Site, a biological resource assessment was performed in 1996 to re-evaluate the diversity of plant and animal species (Adolphsson and Associates, 1996). The studies compared highly contaminated areas within the Consent Decree boundary to similar uncontaminated off-Site reference areas by placing grids over the study areas and identifying and counting plants and wildlife. The majority of plants and animals observed were common to the on-Site and off-Site areas with small differences likely attributable to the higher degree of physical disturbance within the Consent Decree associated with various human activities, such as Site cleanup. There was no indication of plant or animal stress within the Consent

Decree areas. The study concluded that plant and animal populations appear to be healthy. No abnormal growth forms or patterns were observed in either plants or animals in the course of the study. Plant communities appear to be generally healthy and responding to changes in their physical environment that have resulted from initial cleanup and forest thinning activities. Wildlife also are relatively abundant on the Site, and at least some species were observed nesting and/or rearing young within the Consent Decree boundary. This comparative biological assessment found little differences between off-Site and on-Site communities; however, only gross impacts would have been noticed.

A.5 Site-Specific Ecological Studies - A Bottom Up Approach

Quantitative Site-specific studies have been conducted at the former DuPont Works Site as shown below.

- **Screening Soil Bioassays** — The Washington State Department of Ecology performed screening level bioassays on soil samples from the Site as part of its ongoing effort to develop methods to assess potential biological impacts (Norton and Stinson, 1993). The bioassays included (1) *Daphnia magna* percent survival; (2) Plant vigor based on biomass, percent germination, and percent survival; (3) Earthworm percent survival; (4) Fathead Minnow percent survival; (5) FETAX (Frog Embryo Teratogenesis Assay) percent survival, percent malformation, and mean growth of *Xenopus laevis* as presented in Table A-1. These bioassay results suggest that potentially detrimental effects were only observed at the high concentrations (the high concentration was 110,000 ppm). During 1999, 2000, and 2001 the areas with the highest lead concentrations (i.e., any sample where the lead concentration exceeded 4,100 mg/kg) have been removed from the Site (See the RI).

- **Draft Ecological Risk Assessment** — This study evaluated the impacts of Site-related COPCs on the environment (DERS and Hart Crowser, 1994). The assessment employed a food web model to quantify potential exposure of larger animals to contaminants in the soil and compared surface water and sediment constituent concentrations to standards. The assessment concluded that: (1) the potential risk to avian species under current Site conditions was minimal; (2) cleanup of lead to levels protective of human health would be reasonably protective of ecological receptors; and (3) that no potential risks to aquatic species were indicated under current Site conditions. Results of the food web modeling analysis indicated that no potential risk to large terrestrial mammals exists (deer and fox). Potential risks to herbivorous rodents (voles) were identified for some areas. A short coming of this study was that it did not take into account future land use (i.e., what habitat will remain after remediation and development).

- **Food Web Modeling** — A nationally recognized ecological risk assessor selected by Ecology and the PLPs initiated the development of a food web model which focused on highly exposed indicator species found at the site and taking into account the COPCs (Greg Linder, 1996). Ecology and the PLPs came to separate but similar conclusions that future land use was becoming an overriding factor with respect to potential ecological risk: hence this evaluation was no longer needed for making a final decision at the Site.

A.6 Conclusions

A variety of different studies, using both the top down and bottom up approaches to ecological risk assessment, have been conducted at the Site in order to provide information for making an ecologically-based, risk management decision. The conclusions that can be drawn from these studies include:

- The only constituent and medium of potential ecological concern is lead in surface soil. Ecology has performed an evaluation of the Site and determined that lead is the indicator compound for potential terrestrial ecological impacts. As part of this evaluation, Ecology determined that based on site-specific information, the potential species groups of concern included ground-feeding birds and herbivorous small mammals. The conclusion that lead is the only constituent of concern is supported by the fact that the value for arsenic (see Table 749-3 of MTCA) that is protective of wildlife is higher than any of the proposed soil arsenic remediation levels (except for the golf course placement area

remediation levels where an ecological exposure barrier will be present) that are protective of human health.

- Areas that will not be developed in the future are the only areas of concern for evaluating the potential impacts to ecological receptors.
- Lead contamination in surface soil at the Site is primarily localized around building foundations. The soil around these foundations will be remediated, reducing or eliminating exposure to lead.
- No differences in the numbers or condition of plants and animals in contaminated and uncontaminated areas were observed in the qualitative environmental evaluations at the Site. Generations of plants and animals have lived at the Site in the current state since the plant began operating in 1909.
- Screening bioassays performed at the Site suggest that some impacts might be expected to occur to ecological receptors of concern where concentrations of lead are greater than 500 mg/kg. With the exception of soils adjacent to the building foundations, there are minimal areas on site where this level of contamination is present.
- The potential ecological concerns at the site have diminished as development plans have become more concrete and as a result of the Interim Source Removals and Interim Corrective Actions.

As discussed previously, the results of the ecological risk assessment are but one of several pieces of information used by decision makers in reaching risk management decisions. In the case of the former DuPont Works Site, there are healthy and robust flora and fauna Site-wide. Remedial actions planned to protect human health will substantially reduce or eliminate further risk to ecological receptors in many areas of the Site, except in relatively small areas which will remain as Open Space or buffers. In these latter areas, based on the Site-specific data generated to date, the potential risk to ecological receptors is believed to be minimal. Two lines of evidence support this conclusion: 1) the presence of viable, healthy flora and fauna; and, 2) the comparatively small areas where soil lead is in excess of 500 mg/kg. Based on planned land use, it is also evident that these viable and valued habitats will remain so in the future. Overall, the incremental reduction of ecological risk that might be gained by active remediation in the Open Space and buffers is insufficient to outweigh the ecological costs that would result. Therefore, not pursuing additional remedial action in the Open Space and bugger areas will result in a net environmental benefit.

Table A-1 – Soil Bioassay Results

COPC Concentrations	Lead (mg/kg)	Results
Low	8.8	No significant effects.
Medium	490	Four of five bioassay results indicated no significant effects. FETAX results were different from the controls for percent survival and percent malformations.
High	110,000	Three of five bioassay results indicated effects different from the controls. These included percent survival in the *Daphnia magna* and Earthworms, and percent survival and percent malformations for the FETAX bioassay.

A.7 References

Adolphson and Associates. 1996. Biological Resources Assessment. The Weyerhaeuser/DuPont Site. DuPont, Washington.

DERS (DuPont Environmental Remediation Services) and Hart Crowser. 1994. Draft Risk Assessment, Former DuPont Works Site. DuPont, Washington.

Greg Linder, 1996

Hart Crowser. 1994. DRAFT Remedial Investigation, Former DuPont Works site, DuPont, Washington.

Melchiors, M.A. and D.T. Motobu. 1978. Final Report: Terrestrial Ecology of the DuPont Site, Washington. Weyerhaeuser Company. Western Forestry Research Center. Centralia, WA.

Norton, D. and M. Stinson. 1993. Soil Bioassay Pilot Study: Evaluation of Screening Levels Bioassays for Use in Soil Toxicity Assessments at Hazardous Waste Sites Under the Model Toxics Control Act. Olympia, Washington.

U.S. Army Corps of Engineers. 1982. Final Environmental Impact Statement, Weyerhaeuser Export Facility at DuPont, DuPont, Washington.